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Volume 21, The Eighth SeaWiFS Intercalibration Round-Robin Experiment (SIRREX-8), September–December 2001

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Abstract

This report documents the scientific activities during the eighth SeaWiFS Intercalibration Round-Robin Experiment (SIRREX-8) held at the Center for Hydro-Optics and Remote Sensing (CHORS), the Joint Research Centre (JRC), and Satlantic, Inc. The objectives of SIRREX-8 were to a) quantify the uncertainties associated with measuring the immersion factor with a standard protocol, b) establish if instrument-to-instrument variability prevents the assignment of a set of immersion factors for an entire series of sensors, c) compare average immersion factors obtained from sample OCI-200 radiometers with those provided by Satlantic for the same series of instruments, and d) measure the cosine response of one sensor at CHORS and Satlantic. An overview of SIRREX-8 is given in Chapt. 1, the immersion factor methods used by the participating laboratories are presented in Chapts. 2–4, and the data processing code is documented in Chapt. 5. The cosine response methods and results are presented in Chapt. 6, along with an analysis of the data. A synthesis of the immersion factor results is presented in Chapt. 7 and includes a discussion and conclusion of the effort with respect to the objectives.

Prologue

The purpose of the Sea-viewing Wide Field-of-view Sensor (SeaWiFS) Project at the National Aeronautics and Space Administration (NASA) Goddard Space Flight Center (GSFC) is to obtain valid ocean color data of the world ocean for a five-year period, to process that data in conjunction with ancillary data to meaningful biological parameters, and to make that data readily available to researchers (Hooker et al. 1992). The success of the SeaWiFS mission will be determined by the quality of the ocean color data set and its availability. The culmination of properly executing this responsibility is achieving a radiometric accuracy to within 5% absolute and 1% relative, water-leaving radiances to within 5% absolute, and chlorophyll *a* concentration to within 35% over a range of $0.05–50.0\,\mathrm{mg\,m^{-3}}$ (Hooker and Esaias 1993).

The type and quality of supporting *in situ* optical measurements and analytical protocols for SeaWiFS calibration and validation were drafted at a SeaWiFS workshop in 1990. A central perspective of the workshop was that the significant expense of field work dictates *in situ* observations will accrue over several years from a variety of sources, using different instruments and approaches. These data must be internally consistent, of known and documented accuracy (but within SeaWiFS requirements), and in a form readily accessible for analysis by ocean color scientists. The findings and recommendations of the workshop were presented by Mueller and Austin (1992) and were immediately adopted as the SeaWiFS Ocean Optics Protocols (SOOP).

Although the immediate concerns of the SOOP were the SeaWiFS mission, the capabilities of other potential ocean color sensors were also recognized, with the intent of developing databases that are relevant to long-term future needs. The importance of the SOOP and the accuracy requirements contained therein is well recognized by the broader scientific and commercial ocean color community, as evidenced by the considerable expansion of the original document to accommodate a broader range of measurements, techniques, and sampling considerations (Mueller and Austin 1995, Mueller 2000, and Mueller et al. 2001).

Ensuring the SeaWiFS calibration and validation field data sets are of uniform quality and have an uncertainty less than 5% requires a continuing commitment to quantifying the uncertainties associated with the spaceborne and *in situ* instrumentation. The uncertainties associated with the satellite sensor are not considered here, although it is important to remember that half of the total uncertainty budget is apportioned to the satellite sensor. Assuming the uncertainties combine in quadrature (the square root of the sum of the squares), the allowed uncertainty in the remote and *in situ* optical data is approximately 3.5% for each ($\sqrt{5^2/2}$).

The sources of uncertainty for the ground truth part of the total uncertainty budget have a variety of sources:

1. The measurement protocols used in the field;
2. The environmental conditions encountered during data collection;
3. The absolute calibration of the field radiometers, which must also be traceable to the National Institute of Standards and Technology (NIST);
4. The conversion of the light signals to geophysical units in a data processing scheme; and
5. The stability of the radiometers in the harsh environment they are subjected to during transport and use.

The first step in the process of controlling uncertainties in field data was establishing and publishing the SOOP. The proper application of the SOOP also reduces any unnecessary contributions from environmental effects, but it does not completely remove them—as environmental conditions worsen, which may be unavoidable, uncertainties inexorably increase.